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from: W. O. Campbell

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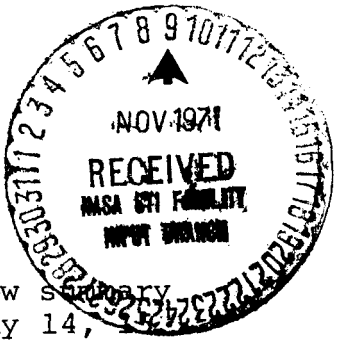
subject: KSC Thunderstorm Probabilities by the Month of the Year - Case 320



MEMORANDUM FOR FILE

The Apollo 16 preliminary launch window summary includes March 17 and 18, April 16 and 17 and May 14, [illegible] and 16. The launch options depend in part upon the thunderstorm frequencies projected for KSC for these months. This memorandum supplies the pertinent thunderstorm data. The data show (1) the variability of thunderstorm frequencies at KSC and (2) the day-by-day smoothed probabilities by months of the year.

Figure 1 contains data[1] from 1223 thunderstorms which occurred on 912 days during a period of 13 years at or in the immediate vicinity of KSC. These observed thunderstorm frequencies show a wide variability. For example, ten thunderstorms were observed on the 13 August firsts. The unsmoothed ratio for August first is accordingly 100x10/13 = 77 percent (Figure 1). By way of contrast only one thunderstorm was recorded on the 13 August twelfths. The corresponding unsmoothed ratio is 7.7 percent, one-tenth that for August first.

The wide variability thus noted makes it advisable to provide some smoothing of the data as an aid in using the data relative to the Apollo 16 launch months. The 15-day moving average (note on Figure 2) has been used on the 13 years of data in order to produce Figure 2. This figure[1] uses the daily frequency data to show monthly trends in the annual thunderstorm cycle.

Several factors[1] (Appendix I) affect the cycle. The peak in March is associated primarily with squall lines. (One such squall line which occurred during the Apollo 9 CDDT is noteworthy because (1) it was correctly predicted by KSC[2]

to arrive in two hours, and (2) the associated winds peaked at 58 knots.) In April the wintertime weather has ceased, yet the effect of solar heating is still at a low level. The month of May is well into the summertime buildup of thunderstorms due to solar heating. The average daily probability during May is about 25 percent, or twice the average probability during March and three times the probability for April 16 or 17.

William O. Campbell

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APPENDIX I

FACTORS WHICH AFFECT THE GENERAL TREND OF THE ANNUAL THUNDERSTORM CYCLE IN THE CENTRAL FLORIDA AREA

The factors which affect the general trend of the annual thunderstorm cycle in central Florida divide the cycle into eight periods[1] (Figure 2):

Period 1: (November through early March) Thunderstorms occur about once per month. They are caused for the most part by instability associated with weather patterns in the central Florida area.

Period 2: (Early March through early April) The marked increase in thunderstorm activity is associated primarily with pre-frontal squall lines.

Period 3: (Mid April) The slight decline in thunderstorm activity is a result of the cessation of winter-time frontal activity and the still insufficient springtime solar heating.

Period 4: (Late April through June) The almost linear increase in thunderstorm activity is associated with the increasing springtime solar heating and the attendant instability. The winds aloft remain predominantly from the west.

Period 5: (First half of July) There is a slight decline in thunderstorm activity. Period 6 provides the explanation.

Period 6: (Latter half of July through early August) There is a second peak in thunderstorm activity. The reason for the mid-July decline and the second peak in thunderstorm activity is probably related to the latitude of the high altitude ridge line. This ridge line is frequently directly over central Florida in July. By late July or early August, however, the ridge line begins the annual retreat to the south.

Period 7: (Early August through the first third of September) The gradual decline in afternoon thunderstorm activity is associated with the decrease in solar heating. The rate of decline is relatively slow during this period because the frequency of nocturnal and early morning thunderstorms reaches a maximum at this time.

Period 8: (Latter two-thirds of September through October) The rapid decline in thunderstorm activity is associated with the decrease in solar radiation. Other contributing factors are the rapid decline of nocturnal thunderstorms and the occasional presence of a tropical cyclone* off the coast of Florida. The latter condition results in the downward movement of the air over Florida and occasionally the intrusion of cooler and drier air into the area.

*such as a tropical low or a hurricane.

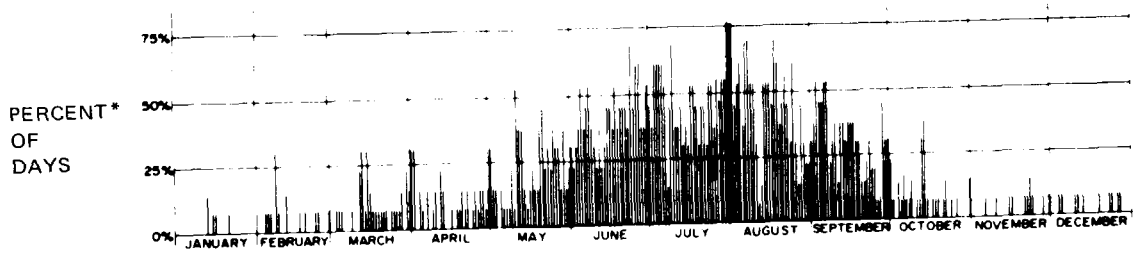

FIGURE 1 - RECORD OF DAILY (0000 – 2400 EST) THUNDERSTORM OCCURRENCES OVER A 13-YEAR PERIOD AT OR IN THE IMMEDIATE VICINITY OF KENNEDY SPACE CENTER

***77 PERCENT, AUGUST 1: 10 THUNDERSTORMS RECORDED ON THE 13 AUGUST FIRSTS.**

7.7 PERCENT, AUGUST 12: ONE THUNDERSTORM RECORDED ON THE 13 AUGUST TWELFTHS.

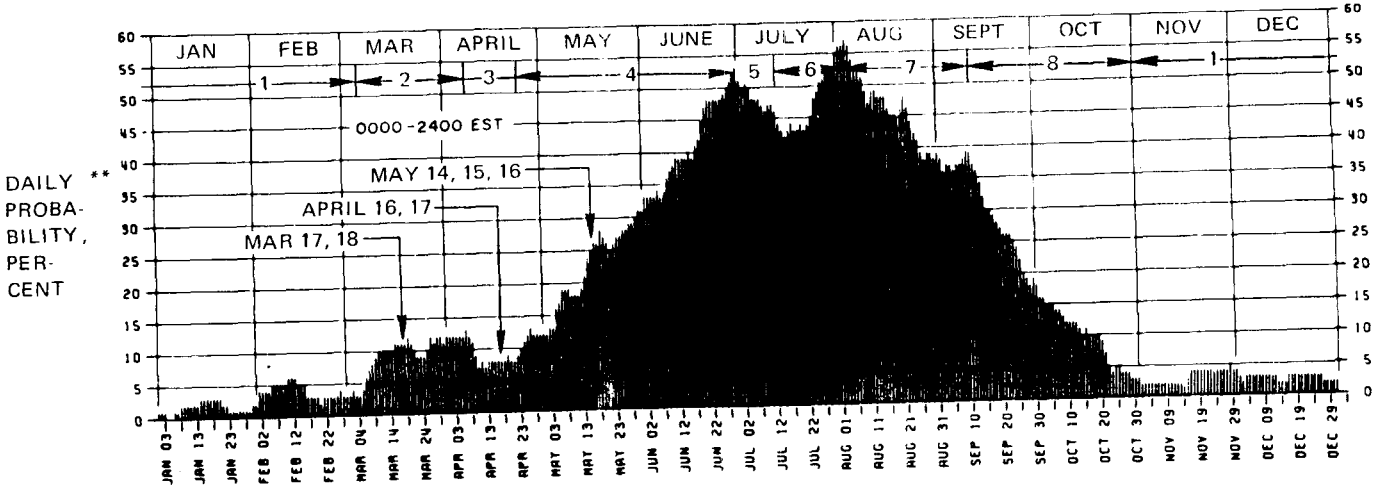

FIGURE 2 - DAILY AND MONTHLY TRENDS IN THE ANNUAL CYCLE OF THUNDERSTORMS AT OR IN THE IMMEDIATE VICINITY OF KENNEDY SPACE CENTER

****15-DAY MOVING AVERAGE EMPLOYED FOR SMOOTHING. THE PROBABILITY IS AN ESTIMATE OF THE TRUE PROBABILITY. 13 YEARS OF DATA USED.**

THE 15-DAY MOVING AVERAGE FOR AUGUST FIRST = THE THUNDERSTORMS THAT OCCURRED BETWEEN JULY 25 AND AUGUST 8 DURING THE 13 YEARS, ÷(15x13), CONVERTED TO PERCENT.

REFERENCES

1. Neumann, C. J., "Frequency and Duration of Thunderstorms at Cape Kennedy," Weather Bureau Office of Meteorological Operations, Space Operations Support Division, Silver Spring, Maryland, WBTM SOS-2; Part I: June, 1968; Part II: May, 1970.

2. Amman, E. A., Informal conversations, KSC, TS-MET, September 1, 8 and 9, 1971.

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